BROOKHAVEN NATIONAL LABORATORY
PROCESS ASSESSMENT FORM

I. General Information

Process ID:	AM-525-MAO			
Process Name:	Mechanical Assembly Operations			
Process Flow Diagrams:	AM-525-MAO-01			
Process Description:	The process includes the Mechanical Assembly Operations associated with the fabrication of the Superconducting magnets and other components conducted in Buildings 902, 905 and 924 at BNL. Mechanical assembly refers to the physical assembly of various components into a finished part by fastening, gluing, soldering or welding. Section II and the above-referenced Process Flow Diagrams provide more detail on the Mechanical Assembly Operations.			
Dept./Div.:	Superconducting Magnet Division			
Dept. Code:	AM			
Building(s):	902, 905, 924			
Room(s):	N/A			
Point of Contact:	M. Gaffney	X8236		
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II. Detailed Process Descriptions and Waste Determination

Superconducting magnets are designed to bend and focus ion beams used in accelerator/collider projects at BNL and other laboratories. Superconducting Magnet Division designs, fabricates, tests and repairs superconducting magnets. The magnets are cooled to 4.6°K (and lower) using either liquid helium or supercritical helium gas. At cryogenic temperature, the magnets acquire superconducting properties, thereby greatly reducing the amount of electricity that must be supplied to generate the magnetic field.

Process Flow Diagrams AM-525-MAO-01, provided in Attachment 1, graphically depict the process inputs and outputs for the Mechanical Assembly Operations. Dvirka and Bartilucco Consulting Engineers originally developed these diagrams to support electronic assembly operations associated with the fabrication of the Relativistic Heavy Ion Collider (RHIC). The processes are still in use and controls developed continue to be applicable.

Superconducting Magnet Division performs mechanical assembly operations in Buildings 902, 905 and 924. Mechanical assembly refers to the physical assembly of various components into a finished part by fastening, gluing, soldering or welding.

Note: The Muon Tracker Chambers for the PHENIX detector were assembled within clean rooms/tented areas in Building 905 and were originally included in this evaluation. The assembly of these detectors has been completed and processes are no longer applicable to SMD.

Superconducting magnets are primarily assembled in Building 902, with subassemblies processed in Building 905. Superconducting coils are produced in Building 924. Forming, Pressing and Winding Machines have been installed in Building 924 and to Building 902 to support the Large Hedron Collider (LHC) program. The final mechanical assembly of the magnets involves fastening, soldering or welding the various parts of the magnet assembly. Mechanical assembly also includes the baking of a plastic heat-activated insulating tape (Kapton), or curing of heat-activated epoxies onto the magnets using an electric oven. In addition to mechanical assembly operations, Building 902 contains a small staff shop, cryogenic fluid production and testing systems, small scale tinning operations and electronic assembly operations.

Chemical usage and waste generation is similar at all facilities where mechanical assembly operations are conducted, except for a few variations due to the specific type of work conducted in each building. In general, chemicals such as ethanol, methanol, isopropyl alcohol (IPA) and acetone are used to clean the parts during assembly operations. Ethanol is the primary solvent used for cleaning. Acetone is only used when other solvents are not effective (particularly in removing epoxy resins). Silver/tin or indium solder is used to assemble parts which will be in contact with the cryogenics (supercritical helium). Parts that are not in contact with the cryogenic fluids can be soldered using lead/tin solder.

A complete list of chemicals utilized by the Superconducting Magnet Division is tracked using the BNL Chemical Management System (CMS). Current lists of chemical assigned to the Division can be found using the BNL CMS web site. Not all of the chemicals listed in the CMS list or located in SMD Buildings are used on a regular basis. When projects are completed, the chemicals used for that particular project typically remain in storage cabinets at the building for possible use in the future.

In general, waste generated in during mechanical assembly operations is recycled if applicable and the containers are available, or discarded to the regular trash (unused epoxies are cured, hardened and disposed of as regular trash). Welding and soldering/flux fumes are typically vented through a smoke eater to ambient air. Soldering machines and the curing oven used for coil production, located in Building 902, are vented to the outside air.

Note: If repairs are made to magnets that have been installed in an accelerator/collider, the machined components and removed failed components are examined for radioactivity. If radioactivity levels are above regulatory limits, the material will be handled and disposed of as radioactive waste.

Regulatory Determination of Process Outputs

Superconducting magnets for RHIC and for other off-site laboratories contain coils of superconducting material that are wound on machines by SMD. The material is a combination of Niobium (Nb)–Tin (Sn) or Nb-Titanium (Ti). There are two types of coils being produced by SMD, dipole and wire wound. There is also a research and development (R&D) project to develop a higher temperature superconducting common coil.

Long Dipole magnet coils are produced in Building 924. Coils are superconducting cables are first wrapped with layers of kapton insulation that has a thermoplastic adhesive. The coils are wound on a mandrel using an automated winding machine with spacers, coated with polyetherimide resin, inserted as needed to give the coil the desired shape. After the coil has been wound, additional insulation is added then the mandrel/coil assembly is placed in a forming press. While under hydraulic pressure, the forming press uses hot oil (Therminol 59) flowing through the mandrel and around the outside of the coil in form blocks to melt the thermoplastics and polyethermides. There are two (2) curing press systems in operation. The first system was originally installed at Northrop Grumman to support RHIC magnet production and placed into service in Building 924 in 2000. The system supports a long curing/collaring press (used for RHIC/LHC Dipoles) and a short long curing/collaring press (used for RHIC quadapoles). Smoke collectors are used to remove any fumes from residual oil in the press. Once formed, the oil is cooled first using an oil-to-air heat exchanger then using a single-pass oil to water heat exchanger. The water (approximately 69,000 gallons per cure) is supplied from the lab's domestic water supply and is discharged to a monitored sump (HN). Discharges are monitored monthly for oil and grease under a National Pollutant Discharge Elimination System (NPDES); New York State (NYS) permit (number NY0005835 discharge number - 002M). The second system was installed in Building 924 in the 1980's. It also supports a long and short press (short press is not in service). This system also uses an oil-to-air heat exchanger and oil-to-water heat exchanger. However, the water currently discharges to an unmonitored sump to the southeast corner. It was determined that the oil-to-water system is not required if air temperatures are less than 80°F. Since the expected use for the system is only for a limited amount of programs, the oil-to-water system was secured and water lines capped. An exhaust fan system is used to remove the heated oil fumes from the building. This emission point is classified as trivial under the site wide Title V Air Permit from NYS.

Operating procedures for the press require careful monitoring of oil inventory and notification to environmental representatives of any unexplainable loss of oil from the system. The hydraulic and heating oil (Therminol 59) systems are located in an annex to building 924. The floor of the annex has been designed as secondary containment for the system (up to 800 gallons). The oil-to-air heat exchangers are located outside of the annex, also in secondary containment. To manufacture dipole magnets for particle accelerators, two (2) coils are collared around an insulated beam tube. A hydraulic press compresses the collars so a key can be inserted, locking the collars around the tube. In Building 924, the hydraulics from the forming press is used (these collars also contain the yokes for the magnets). Building 905 has a smaller hydraulic press or collaring magnets that yokes are installed during final construction.

Some magnets use a wire wound techniques (used for RHIC helical spin and rotator magnets and for the HERA luminosity Upgrade program at DESY). Superconducting wire is either hand or machine wound on tubes using epoxy-impregnated substrates to form the specific pattern (RHIC helical magnets are wound in grooves machined in tubes whereas DESY magnets are wound to the tubes exterior). One process used included the application of fiberglass and Kevlar yarns to magnet coils with epoxy adhesives while under a fume hood (reference SMD OPM 8.1.1.16) until the adhesives dried. Under the Title V Air Permit from NYS, this process was classified as an emission source (Emission Unit ID: U-COILS) ***(Note: When the process was relocated from Building 197 to 902, it was determined the fume hood face air flow was less than the required 100 cubic feet per minute, therefore, all operations will using the system will require Work Planning and Controls)***. An oven is used to cure the epoxy. The oven, located in Building 902 is ventilated directly to the outside. The oven is also used for the curing of the insulation on the beam tube. In addition to this oven, the beam tube-wrapping machine has a quartz oven to activate the adhesives on insulation/film (typically Kapton). An exhaust fan system is used to remove fumes from the building. The emission points are classified as trivial under the site wide Title V Air Permit from NYS.

The Common Coil Program is a research and development (R&D) project for magnets that can generate very high magnetic fields at higher superconducting temperatures (i.e., 80°K). The coils are wound with high temperature superconducting cable by hand and machine (in Building 924). Epoxy is used to maintain shape. The epoxy is drawn into the coil using a vacuum fixture and cured using heaters in Building 902. The coil is mechanically fastened in a steel containment mass.

Final mechanical assembly is in Building 902. The final mechanical assembly of the magnets involves fastening, soldering or welding the various parts of the magnet assembly. To support the LHC magnet program, a hydraulic press has been installed in Building 902 to supply pressure to the magnet cold mass pressure vessel (parts of the magnet cooled to superconducting temperatures) during the welding processes. Parts are soldered manually or in soldering machines. Solder tailings are collected and either reused (by melting in solder pots) or disposed of (if contaminated to a point the reuse is not practical) as hazardous waste. Solder and flux fumes from manual soldering and welding fumes are captured and filtered through a smoke eater and then discharged to ambient air. Spent smoke eater filters are drummed and transferred to the Hazardous Waste Management Facility (HWMF) for disposal as hazardous waste (approximately one drum per year).

The Spallation Neutron Source (SNS) Half-cells are produced in Building 902. The SNS Half-cells are made up of different configuration of conventional (non-superconducting) magnets. The individual magnet components are manufactured off-site and are sent to BNL for testing and assembly. An anti-freeze (glycol)/water mixture is used to cool the magnets during testing. After testing, the cooling water is placed into 55-gallon drums and is disposed of as industrial waste. Different combinations of magnets are mechanically attached to a girder to form a cell assembly.

Chemicals used for cleaning parts during assembly include ethanol, methanol and acetone. Ethanol is the primary cleaning solvent, however acetone is used on occasion when cleaning with ethanol is ineffective. Chemicals such as ethanol, methanol and acetone are stored in large (typically 5 gallon) containers within flammable cabinets. These large chemical containers are used to refill reusable plastic spray bottles. Empty containers from other chemicals used in smaller quantities and spray paint are discarded in the regular trash. Paper rags are used for cleaning and the spent rags are discarded in the regular trash, along with used cloth and latex gloves. Any scrap metal generated during final assembly of the magnets is placed in the appropriate collection container for off-site recycling. Also, cardboard from shipping containers is placed in the appropriate container for off-site recycling. Plant Engineering collects scrap wood for disposal. Aerosol paints and degreasers are primarily used in fume hoods. The exhaust from these hoods and the bus bar tinning operations has been categorized as trivial sources under the laboratory's NYSDEC Title V permit. Logbooks are maintained at the hoods to record the estimated emissions from this and other processes. Posting at these points list evaluated activities.

Note: If repairs are made to magnets that have been installed in an accelerator/collider, the machined components and removed failed components are examined for radioactivity. If radioactivity levels are above regulatory limits, the material will be handled and disposed of as radioactive waste. Since this is a rare occurrence, it has not been added to Process Flow Diagram because specific procedures are developed as required.

Waste ID	Waste Description	Determination/Basis	Waste Handling	Corrective Action Required
1.1	Scrap wood	Non-hazardous solid waste as determined by process knowledge	Waste is placed in the appropriate container for collection by Plant Engineering and disposal	None
1.2	Cardboard containers	Non-hazardous solid waste as determined by process knowledge	Waste is placed in the appropriate collection container for off-site recycling	None
1.3	Soldering machine and Kapton oven/curing press fumes	Non-hazardous vapors as determined by process knowledge	Vapors are vented directly to the outside air	None
1.4	Soldering/flux, hot oil and welding fumes	Non-hazardous vapors as determined by process knowledge	Vapors are captured and filtered through a smoke eater and discharged to ambient air	None
1.5	Spent rags and empty containers	Non-hazardous solid waste as determined by process knowledge	Waste is discarded in the regular trash	None
1.6	Cloth and latex gloves	Non-hazardous solid waste as determined by process knowledge	Waste is discarded in the regular trash	None

Waste ID	Waste Description	Determination/Basis	Waste Handling	Corrective Action Required
1.7	Soldering and welding smoke eater filters	Non-hazardous solid waste as determined by process knowledge	Waste is transferred to HWMF for disposal as hazardous waste	None
1.8	Scrap metal	Non-hazardous solid waste as determined by process knowledge	Waste is placed in the appropriate collection container for off-site recycling	None
1.9	Fugitive VOC emission from cleaning solvents	Non-hazardous fugitive emission	Released to room	None
1.10	Waste Solder	Hazardous waste if it contains lead or silver. Satellite accumulation containers for lead and silver solder wastes established	Solder reused if possible or transferred to HWMF for disposal as hazardous waste.	None
1.11	Cooling Water to Sump	Non-hazardous liquid waste as determined by process knowledge	Water is sent to sump monitored monthly for oil.	None
1.12	Epoxy/adhesive vapors	Non-hazardous vapors as determined by process knowledge	Fumes are either released to room or to outside air using hoods or vent systems	None

III. Waste Minimization, Opportunity for Pollution Prevention

Mechanical assembly operations associated with Superconducting Magnet Division programs undergo a safety review by the ES&H Coordinator prior to implementation. Waste minimization (and environmental compliance) is included in this review as well as during the Engineering Design Review Process (for new programs) and/or the Work Planning and Control Process (ES&H Standard 1.3.6). The evaluation of waste minimization opportunities is most effective during the planning stages of an experiment or operation. In addition, all anticipated waste streams from an experiment or operation should be evaluated for environmental compliance prior to implementation to ensure that the appropriate waste management procedures and facilities are in place.

During the initial effort of evaluating SMD's processes for Pollution Prevention and Waste Minimization Opportunities, each waste, effluent, and emission was examined to determine if there were opportunities to reduce either the volume or toxicity of the waste stream. Consideration was given to substitute raw materials with less toxic or less hazardous materials, process changes, reuse or recycling of materials and/or wastes, and other initiatives. These actions were documented in this section of the original process evaluation. Action taken on each of the Pollution Prevention and Waste Minimization items identified can be found in the Environmental Services Division's PEP Database. Further identification of Pollution Prevention and Waste Minimization Opportunities will be made during annual assessments of the SMD processes. If any Pollution Prevention and Waste Minimization Opportunities are identified, they will be forwarded to the Environmental Services Division for tracking through the PEP Database.

IV. Assessment Prevention and Control

During the initial effort of evaluating SMD's Assessment, Prevention, and Control (APC) Measures, operations, experiments and waste that have the potential for equipment malfunction, deterioration or operator error, and discharges or emissions that may cause or lead to releases of hazardous waste or pollutants to the environment or that potentially pose a threat to human health or the environment were described. A thorough assessment of these operations was made to determine: if engineering controls were needed to control hazards; where documented standard operating procedures needed to be developed; where routine, objective, self-inspections by department supervision and trained staff needed to be conducted and documented; and where any other vulnerability needed to be further evaluated. These actions are documented in this section of the original process evaluation. Action taken on each of the Assessment, Prevention and Control Measures is documented in the Environmental Services Division's PEP Database. Further identification of Assessment, Prevention and Control Measures will be made during annual assessments of SMD processes. If any Assessment, Prevention and Control Measures are identified, they will be forwarded to the Environmental Services Division for tracking through the PEP Database.

ATTACHMENT 1

PROCESS FLOW DIAGRAM
AM-525-MAO-01